



EVALUATION PROGRAM
for
SECONDARY SPACECRAFT CELLS

INITIAL EVALUATION TESTS
OF
EAGLE - PICHER INDUSTRIES, INCORPORATED
6.0 AMPERE-HOUR, NICKEL-CADMIUM SPACECRAFT CELLS
FOR
SEPARATOR MATERIAL EVALUATION
prepared for
GODDARD SPACE FLIGHT CENTER
CONTRACT S-23404-G

(NASA-CR-141231) EVALUATION PROGRAM FOR
SECONDARY SPACECRAFT CELLS: INITIAL
EVALUATION TESTS OF EAGLE-PICHER INDUSTRIES,
INCORPORATED 6.0 AMPERE-HOUR, NICKEL-CADMIUM
SPACECRAFT CELLS FOR SEPARATOR (Naval)
63/44 10270
Unclass
N75-17789

WEAPONS QUALITY ENGINEERING CENTER
NAVAL AMMUNITION DEPOT, CRANE, INDIANA

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FOR
SEPARATOR MATERIAL EVALUATION

WQEC/C 75-32

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Enclosure (1)

REPORT BRIEF
INITIAL EVALUATION TESTS
OF
EAGLE-PICHER INDUSTRIES
6.0 AMPERE-HOUR NICKEL-CADMIUM SPACECRAFT CELLS
FOR
SEPARATOR MATERIAL EVALUATION

Ref: (a) NASA Purchase Order S-23404-G
(b) Initial Evaluation Test Procedure for Nickel-Cadmium
Sealed Space Cells: NADC 3053-TP324 of 10 Apr 73

I. TEST ASSIGNMENT BRIEF

A. The purpose of this evaluation test program is to insure that all cells put into the life cycle program are of high quality by the screening of cells found to have electrolyte leakage, internal shorts, low capacity, or inability of any cell to recover its open-circuit voltage above 1.150 volts during the internal short test.

B. The 66 cells, comprising 10 groups, were manufactured for the National Aeronautics and Space Administration, Goddard Space Flight Center, under NASA contract number NAS-5-17806, by Eagle-Picher Industries, Joplin, Missouri. They were manufactured to Goddard Space Flight Center's specification number S-716-P-6. All the cells had auxiliary electrodes, but these electrodes were not evaluated since the purpose of this test was to evaluate various separator materials. The cells were identified by Eagle-Picher's type number, RSN-6B, and serial numbers 1 to 70, non-inclusive. Two groups of cells had nylon separator material and the other groups had polypropylene. These cells are rated at 6.0 ampere-hours, contain double ceramic seals, and two cells in each group were fitted with pressure gauge assemblies prior to testing. Testing was funded in accordance with reference (a).

C. Test limits specify those values in which a cell is to be terminated from a particular charge or discharge. Requirements are referred to as normally expected values based on past performance of aerospace nickel-cadmium cells with demonstrated life characteristics. A requirement does not constitute a limit for discontinuance from test.

II. SUMMARY OF RESULTS

A. One cell, S/N 46, with Hercules separator material, would not charge. Its initial resistance was 10 milliohms.

B. Only those cells with the PP-Canadian separator material and those with the N-Pellon material (groups R and F respectively) completed their initial charge without exceeding any test limits.

C. No group of cells completed their second charge, c/10 for 24 hours, without having any cell exceed a test limit.

D. Group R cells, with the PP-Canadian separator material, averaged the highest ampere-hours out (8.3) during the first capacity test, whereas Group O, PP-Grace material, averaged the lowest (5.8). Two cells each, from Groups O and N (PP-Grace material) did not deliver the rated capacity of 6.0 ampere-hours following this charge.

E. Group F cells, with the H-Pellon material, exhibited the highest average ampere-hours out (7.6) during the second capacity test. Group H cells averaged the lowest, 5.6 ampere-hours, in which five cells did not deliver rated capacity. Two cells each, from Groups L and O, and five cells from Group M did not deliver rated capacity. These groups have the PP-Grace type material.

F. During the charge efficiency test, only one cell each, from Groups R and F, failed to deliver the minimum capacity out requirement of 55 percent of capacity in, whereas Groups O and S had one cell each to pass this requirement.

III. RECOMMENDATIONS

A. It is recommended that these cells be placed into the life cycling program for comparison of performance of the various types of separator material.

B. As of 14 November 1974, 10 battery packs, one made up of cells from each group, were on life cycle test.

RESULTS OF
INITIAL EVALUATION TESTS
OF
EAGLE-PICHER INDUSTRIES
6.0 AMPERE-HOUR NICKEL-CADMIUM SPACECRAFT CELLS
FOR
SEPARATOR MATERIAL EVALUATION

I. TEST CONDITIONS AND PROCEDURE

A. All evaluation tests were performed at room ambient (RA) pressure and temperature ($25^{\circ} \pm 2^{\circ} \text{C}$), with discharges at the 2-hour rate, and in accordance with reference (b), and consisted of the following:

1. Phenolphthalein leak tests (2).
2. Two capacity tests, with internal resistance measurement following the second discharge.
3. Internal short test.
4. Charge efficiency test.
5. Phenolphthalein leak test.

(See Appendix I for summary of test procedure.)

II. CELL IDENTIFICATION AND DESCRIPTION

A. The 66 cells were manufactured with 10 various types of separator material. The cells were identified by the manufacturer type number, RSN-6B, and by serial numbers. Following is a listing of the serial numbers, type separator, group and test pack number.

<u>Group</u>	<u>Separator Material*</u>	<u>Cell S/N</u>	<u>Test Pack</u>
L	PP-Grace 3073-23	1-7	9L
M	PP-Grace 3073-35	8-14	9M
N	PP-Grace 3074-18	15-17,19-21	9K
O	PP-Grace 1972-31W	22-26,28	9O
P	PP-Grace 3073-32W	29-35	9P
Q	PP-WEX 1242 RAI	36-42	9Q
J	PP-Hercules 2711-55	44-47,49	9J
R	PP-Canadian WEX-ISIS	50-55	9R
F	N-Pellon 2505 (Control)	56-63	9F
S	N-Grace Extracted	64-70	9S

* PP - Polypropylene
N - Nylon

Each group had two cells fitted with pressure gauge assemblies prior to testing.

B. The 6.0 ampere-hour cell is rectangular with an average weight and physical dimensions as follows:

<u>Weight (g)</u>	<u>Height (In)</u>	<u>Length (In)</u>	<u>Width (In)</u>
291.0	3.795	.852	2.100

Individual cell measurements are listed in Table 1.

C. The cell containers and covers are made of stainless steel. The positive and negative terminals are insulated from the cell cover by ceramic seals and protrude through the cover as solder-type terminals.

(See Appendix II for detailed cell description.)

III. RESULTS--The following was condensed from Tables I through III.

A. One cell, S/N 46, with Hercules separator material, would not charge. Its internal resistance was 10 milliohms.

B. Three cells, S/N's 8, 10 and 32, initially indicated leaks at the base of their fill tube, but did not indicate leaks after high vacuum or following test.

C. Only two groups of cells (R and F), with PP-Canadian and H-Pellon separator material, completed the initial charge without having any cells removed from charge due to high cell voltage (1.520 volts) or high pressure (100 psia).

D. No group of cells completed the second charge, c/10 for 24 hours, without having any cells removed because of high voltage or pressure.

E. Group R cells, with the PP-Canadian separator material, averaged the highest ampere-hours out (8.3) during the first capacity test, whereas Group O, PP-Grace material, averaged the lowest (5.8). Two cells each, from Groups O and N, did not deliver the rated capacity of 6.0 ampere-hours following this charge.

F. Group F cells, with the H-Pellon material, exhibited the highest average ampere-hours out (7.6) during the second capacity test. Group H cells averaged the lowest, 5.6 ampere-hours, in which five cells did not deliver rated capacity. Two cells each, from Groups L and O, and five cells from Group M did not deliver rated capacity. These groups have the PP-Grace type material.

G. During the charge efficiency test, only one cell each, from Groups R and F, failed to deliver the minimum capacity out requirement of 55 percent of capacity in, whereas Groups O and S had one cell each to pass this requirement.

H. All cells exceeded 1.200 volts at the end of 24 hours, following a 16-hour short period, during the internal short test.

I. The internal resistance of cells S/N 28, of Group 0, was 9.4 milliohms, whereas the resistance of all the other cells was $4.0 \pm .8$ milliohms.

APPENDIX I

APPENDIX I

I. TEST PROCEDURE

A. Phenolphthalein Leak Tests:

1. This test is a determination of the condition of the welds and ceramic seals on receipt of the cells and following the last discharge of the cells (Cycle #3).

2. The cells were initially checked with a one-half of one percent phenolphthalein solution applied with a cotton swab and then placed in a vacuum chamber and exposed to a vacuum of 40 microns of mercury or less for 24 hours. Upon removal they were rechecked for leaks and then received a final check following test completion. The requirement is no red or pink discoloration which indicates a leak.

B. Capacity Tests:

1. The capacity test is a determination of the cell's capacity at the $c/2$ discharge rate to 0.75 volt per cell, where C is the manufacturer's rated capacity. This type discharge follows all charges of this evaluation test.

2. The charges for the capacity tests are as follows:

a. $c/20$, 48 hours, room ambient (RA), Cycle 0, with a test limit of 1.52 volts or pressure of 100 psia.

b. $c/10$, 24 hours, RA, Cycle 1, with a test limit of 1.52 volts or 100 psia pressure and a requirement of maximum voltage (1.48) or pressure (65 psia).

C. Internal Resistance:

1. Measurements are taken across the cell terminals following the discharge of Cycle 2. These measurements were made with a Hewlett-Packard milliohmmeter (Model 4328A).

D. Internal Short Test:

1. This test is a means of detecting slight shorting conditions which may exist because of imperfections in the insulating materials, or damage to element in handling or assembly.

2. Following completion of the second capacity discharge, the cells are shunted with an 0.5 ohm, 3-watt resistor for 16 hours. At the end of the 16 hours the resistors are removed and the cells stand on open-circuit-voltage (OCV) for 24 hours. A minimum voltage of 1.15 is required at the end of 24 hours.

E. Charge Efficiency Test, 25° C:

1. This test is a measurement of the cells' charge efficiency when charged at a low current rate.

2. The cells are charged at c/40 for 20 hours with a test limit of 1.52 volts or 100 psia pressure. They are then discharged and the requirement is that the minimum capacity out equals 55 percent of capacity in during the preceding charge.

APPENDIX II

Cell Design
Eagle-Picher RSN-6 Separator
Cells

1. Cell Case: The cell case is drawn from 304L stainless steel with a wall thickness of 0.025.
2. Cell Header: The cell cover is fabricated from 304L stainless steel and contains two alumina ceramic seals with nickel iron (alloy 42) stress relief collars. The terminal posts are nickel. The brazing alloy used is silver, copper, indium alloy per MIL-B-15395A. The header assembly has a 0.187 O.D. stainless steel fill tube welded to the cover.
3. Positive plates: Each cell contains ten positive plates. The nominal dimension of the plate, not including the tab, are 2.50 in. high, 1.75 in. wide and 0.025 in. thick. A nickel tab is welded to the plate. Plate edges are coined 0.031 in. The capacity of the positive plate is 0.7 ampere hours.
4. Negative Plates: Each cell contains eleven negative plates. The nominal dimensions of the plate, not including the tab, are 2.50 in. high, 1.75 in. wide and 0.028 in. thick. A nickel tab is spot welded to the plate. Plate edges are coined 0.031 in. The capacity of the negative plate is 1.14 ampere hours.
5. Separators: The separators in the cell are listed in the attached table. The electrode/separator assembly is not insulated from the cell case. A jacket, made of the same material as the cell separator, surrounds the electrode/separator assembly.
6. Electrolyte: The electrolyte used in each cell is 31 percent KOH. Electrolyte adjustments during the manufacturer's processing are shown in the attached table.

SEPARATOR MATERIAL	CELL S/N	SEPARATOR COMMENTS (FAB. & ASS'Y.)	KOH (GMS) RETAINED AFTER ACCELERATION	KOH ADDED PRIOR TO 1ST VENTED CYCLE	1ST VENTED CYCLE CAPACITY (APPROX. MIN.)	KOH ADDED (GMS) AFTER 1ST V CYCLE	2ND VENTED CYCLE CAPACITY (APPROX. MIN.)	KOH ADDED AFTER 2ND V CYCLE (GMS)	3RD VENTED CYCLE CAPACITY (APPROX. MIN.)	KOH ADDED AFTER 3RD VENTED CYCLE (GMS)	SEALED CYCLE CAPACITY (APPROX. MIN.)	FINAL KOH ADDITION (GMS)
POLYPROPYLENE GRACE #3073-23	1		23.9									2.5
	2		22.4									3.0
	3		22.1									3.0
	4		22.2									3.0
	5		21.6		85	+5	120		124	+3	115	3.5
	6		23.4									2.5
	7		21.1									3.5
POLYPROPYLENE GRACE #3073-35	8		20.8									3.0
	9		19.9									3.5
	10		19.4									3.5
	11		20.4		55	+7	130		130	+3	120	3.0
	12		19.0									3.5
	13		19.6									3.5
	14		20.6									3.0
POLYPROPYLENE GRACE #3076-18	15		18.9									5.0
	16		17.9									3.5
	17		18.9									3.0
	18		18.1	+5	50	+4	70		80	+3	90	3.0
	19		19.5									5.0
	20		19.1									3.0
	21		19.7									3.0
POLYPROPYLENE GRACE #1972-31W	22		20.5									4.0
	23		21.4									3.5
	24		21.4									3.5
	25		21.7		75		135		130	+3	120	3.5
	26		22.2									3.5
	27		21.5									3.5
	28		21.8									4.0
POLYPROPYLENE GRACE #3073-32W	29		23.3									4.0
	30		23.2									4.0
	31		22.8		120	+3	140		135		118	4.5
	32		22.5									4.0
	33		23.5									4.0
	34		23.5									4.0
	35		22.9									4.5
HEX 1262 RAI	36		19.5									4.0
	37		19.7									4.0
	38		19.9		105		100	+5	145		130	4.0
	39		18.3									5.0
	40		20.3									3.5
	41		19.4									4.0
	42		19.1									4.0
HERCULES MICRO FIBER #2711-55	43		26.8									0.0
	44		24.8									3.0
	45		24.6									3.0
	46		30.0		110		105	+3	125	+3	125	1.0
	47		26.5									3.0
	48		24.8									3.0
	49		25.1									2.0
CANADIAN BATTERY HEX 1515 (6 Cells Only)	50		19.0									3.0
	51		18.2									3.5
	52		18.3		130		130	+3	145		132	3.5
	53		19.8									3.0
	54		19.0									3.0
	55		19.1									3.0
	56		20.7									4.0
PRILON #2303 (6 Cells Only)	57		20.6									4.0
	58		20.9									4.0
	59		20.0		125		125	+4	145		130	4.0
	60		18.8									4.0
	61		21.2									4.0
	62		19.9									4.0
	63		20.0									4.0
GRACE NYLON (EXTRACTED)	64		29.6									3.0
	65		29.6									3.0
	66		31.3		130		135		140		120	1.0
	67		29.9									3.0
	68		29.9									2.0
	69		29.4									3.0
	70		29.4									3.0

CELL TYPE RSN 6B

SUMMARY OF SEPARATOR MATERIAL COMMENTS AND ABBREVIATED PERFORMANCE DATA

TABLE I

SERIAL NUMBER	WEIGHT (Grams)	HEIGHT (Inches)	LENGTH (Inches)	WIDTH (Inches)	PHENOLPHTHALEIN LEAK TESTS											
					Initial				Following H1 Vac				Following Test Completion			
					Terminals		Fill Tube	Other	Terminals		Fill Tube	Other	Terminals		Fill Tube	Other
					+	-			+	-			+	-		
1	294.3	3.794	.841	2.103							↑				↑	
2	295.7	3.807	.851	2.096												
3	290.6	3.794	.846	2.098												
4	291.3	3.790	.833	2.103												
5	290.5	3.790	.851	2.097												
6	291.6	3.770	.844	2.095												
7	292.4	3.813	.854	2.096												
8	292.1	3.790	.851	2.097			✓									
9	292.5	3.792	.855	2.107												
10	290.4	3.765	.861	2.104			✓									
11	292.6	3.815	.855	2.104												
12	289.7	3.804	.835	2.094												
13	293.8	3.804	.827	2.095												
14	291.9	3.785	.854	2.100												
15	288.9	3.766	.855	2.102												
16	290.4	3.804	.852	2.095												
17	287.4	3.785	.840	2.105												
19	289.3	3.811	.842	2.096												
20	287.1	3.814	.834	2.095												
21	289.9	3.807	.828	2.106												
22	295.3	3.801	.857	2.103												
23	294.9	3.790	.857	2.104												
24	292.9	3.804	.846	2.096												
25	290.6	3.813	.844	2.099												
26	292.8	3.808	.854	2.097												
28	295.1	3.797	.866	2.102							↓				↓	

TABLE I

SERIAL NUMBER	WEIGHT (Grams)	HEIGHT (Inches)	LENGTH (Inches)	WIDTH (Inches)	PHENOLPHTHALEIN LEAK TESTS											
					Initial				Following H1 Vac				Following Test Completion			
					Terminals		Fill Tube	Other	Terminals		Fill Tube	Other	Terminals		Fill Tube	Other
					+	-			+	-			+	-		
29	290.5	3.800	.852	2.103							↑				↑	
30	290.1	3.788	.856	2.104							↑				↑	
31	289.1	3.809	.864	2.097												
32	290.9	3.795	.846	2.107			✓			No	Leaks			No	Leaks	
33	288.9	3.786	.839	2.100												
34	289.4	3.817	.837	2.097												
35	290.7	3.792	.866	2.108												
36	286.0	3.768	.852	2.099												
37	289.7	3.778	.841	2.096												
38	291.9	3.792	.868	2.097												
39	290.9	3.785	.852	2.106												
40	292.3	3.787	.859	2.098												
41	290.2	3.790	.843	2.097												
42	292.6	3.785	.859	2.106												
44	294.8	3.790	.861	2.097												
45	290.3	3.805	.845	2.100												
46	289.7	3.802	.867	2.104												
47	294.7	3.808	.857	2.103												
49	293.7	3.797	.851	2.097												
50	286.0	3.806	.836	2.092												
51	286.9	3.792	.856	2.096												
52	283.9	3.806	.853	2.096												
53	286.7	3.795	.852	2.092												
54	287.4	3.790	.861	2.102												
55	284.9	3.768	.852	2.092												
											↓				↓	

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TABLE 11
CAPACITY AND CHARGE EFFICIENCY DATA

SERIAL NUMBER	CAPACITY TEST 1						CAPACITY TEST 2						CHARGE EFFICIENCY					
	END-OF-CHARGE			END-OF-DISCHARGE			END-OF-CHARGE			END-OF-DISCHARGE			END-OF-CHARGE			END-OF-DISCHARGE		
	CELL (Volts)	AUX ELECT (Volts)	PRESS (PSIA)	CAPAC- ITY (ah)	AUX ELECT (Volts)	PRESS (PSIA)	CELL (Volts)	AUX ELECT (Volts)	PRESS (PSIA)	CAPAC- ITY (ah)	AUX ELECT (Volts)	PRESS (PSIA)	CELL (Volts)	AUX ELECT (Volts)	PRESS (PSIA)	CAPAC- ITY (ah)	AUX ELECT (Volts)	PRESS (PSIA)
1	10.8 *	N/A	37	7.1	N/A	25	10.5 *	N/A	96	6.2	N/A	77	1.371	N/A	50	1.25	N/A	50
2	11.7 *			7.1			11.2 *			6.7			1.370			1.20		
3	11.1 *		45	6.6		22	10.8 *		77	6.7		61	1.370		37	1.25		36
4	11.5 *			7.2			10.9 *			6.7			1.371			1.25		
5	11.1 *			6.9			9.1 *			5.1			1.372			1.25		
6	10.3 *			6.9			9.2 *			6.0			1.372			1.25		
7	10.4 *			6.5			9.0 *			5.8			1.373			1.30		
8	10.2 *			7.2			9.0 *			5.8			1.370			1.46		
9	10.3 *		41	7.1		19	9.0 *		59	5.6		32	1.369		24	1.46		24
10	10.4 *			6.8			9.3 *			6.0			1.369			1.40		
11	10.6 *			7.1			9.3 *			5.6			1.368			1.40		
12	11.1 *		43	7.5		23	9.7 *		70	5.8		56	1.368		34	1.40		34
13	10.8 *			7.4			9.4 *			5.7			1.369			1.40		
14	10.5 *			7.1			9.3 *			5.7			1.371			1.46		
15	1.489		33	6.1		33	1.519/137		100	5.5		37	1.364		22	1.35		21
16	1.504			4.8			11.2 *			5.8			1.367			1.37		
17	1.500		46	5.8		38	1.507/11.4		100	5.8		80	1.364		56	1.44		55
19	12.1 *			6.7			10.5 *			6.0			1.368			1.49		
20	1.472			5.8			1.505			5.2			1.366			1.37		
21	12.0 *			6.8			1.518			5.4			1.364			1.44		
22	13.0 *		77	5.7			1.519/9.9		100	5.7		57	1.373		41	1.58		41
23	1.508			6.5			10.9 *			6.5			1.371			1.69		
24	1.459		80	6.1			1.477/10.7		100	6.1		46	1.371		32	1.53		31
25	1.464			6.1			12.9 *			6.1			1.371			1.53		
26	1.494			6.1			11.1 *			6.1			1.372			1.58		
28	11.7 *			4.1			8.2 *			4.1			1.381			1.53		

9ND-RADC (SP 11/73) * Cells Removed from charge due to High Voltage (1.52 volts), Value indicates A.H. input when removed.
□ - Only 2 cells in each group have pressure gauges ** - Removed from charge due to High Pressure.

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TABLE II
CAPACITY AND CHARGE EFFICIENCY DATA

SERIAL NUMBER	CAPACITY TEST 1						CAPACITY TEST 2						CHARGE EFFICIENCY					
	END-OF-CHARGE			END-OF-DISCHARGE			END-OF-CHARGE			END-OF-DISCHARGE			END-OF-CHARGE			END-OF-DISCHARGE		
	CELL (Volts)	AUX ELECT (Volts)	PRESS (PSIA)	CAPAC- ITY (ah)	AUX ELECT (Volts)	PRESS (PSIA)	CELL (Volts)	AUX ELECT (Volts)	PRESS (PSIA)	CAPAC- ITY (ah)	AUX ELECT (Volts)	PRESS (PSIA)	CELL (Volts)	AUX ELECT (Volts)	PRESS (PSIA)	CAPAC- ITY (ah)	AUX ELECT (Volts)	PRESS (PSIA)
29	13.1 *	N/A	31	7.5	N/A	19	11.0 *	N/A	61	6.8	N/A	37	1.369	N/A	32	1.51	N/A	31
30	1.455			7.5			1.451			7.5			1.371			1.45		
31	1.450		31	7.3		23	11.5 *		55	6.6		31	1.371		26	1.45		25
32	1.469			7.6			1.452			7.3			1.371			1.45		
33	1.495			7.9			1.458			7.5			1.370			1.51		
34	1.447			7.0			1.437			7.0			1.371			1.43		
35	1.478			7.6			10.8 *			6.8			1.372			1.57		
36	1.464		23	7.7		15	1.472		40	7.3		28	1.370		28	1.51		27
37	12.0 *			7.8			10.0 *			7.1			1.372			1.58		
38	1.461		27	7.6		21	1.450		36	7.3		27	1.371		23	1.51		23
39	1.510			8.0			11.1 *			7.0			1.371			1.58		
40	1.456			8.0			1.454			7.5			1.371			1.58		
41	1.514			8.1			1.498			7.7			1.371			1.55		
42	1.464			7.8			1.451			7.5			1.370			1.51		
44	12.2 *		42	7.8			9.8 *		58	6.9		35	1.372		20	1.52		19
45	11.6 *			7.4			9.5 *			6.3			1.372			1.42		
46	N/A		N/A	N/A		N/A	N/A		N/A	N/A		N/A	N/A		N/A	N/A		N/A
47	11.7 *			6.8			9.5 *			6.3			1.374			1.42		
49	1.488			7.7			11.0 *			6.8			1.372			1.47		
50	1.457		23	8.4			11.8 *		48	7.1		23	1.376		34	1.72		33
51	1.441			8.3			1.468			7.6			1.375			1.65		
52	1.438		21	8.3			1.480		31	7.6		23	1.375		25	1.68		25
53	1.443			8.2			1.473			7.6			1.375			1.70		
54	1.438			8.2			1.454			7.5			1.375			1.65		
55	1.445			8.2			1.474			7.5			1.376			1.61		

* - Cells Removed from charge due to High Voltage (1.52 volts), value indicates AH input when removed
 □ - Only 2 cells in each group have pressure gauges. N/A - Not applicable

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TABLE III
INTERNAL RESISTANCE AND SHORT TEST DATA

9ND-NADC (SP 11/73)

SERIAL NUMBER	INTERNAL RESISTANCE (MILLIOHMS)			INTERNAL SHORT TEST		
	END-OF-CHARGE	ONE HOUR AFTER START-OF-DISCHARGE	TWO HOURS AFTER START-OF-DISCHARGE *	AFTER 16 HR SHORT	AFTER 24 HOUR OCV STAND	
				CELL	CELL	PRESS [□]
1	N/A	N/A	3.9	.031	1.213	45
2			4.2	.032	1.214	
3			4.0	.034	1.206	16
4			4.4	.028	1.232	
5			4.3	.034	1.214	
6			4.6	.040	1.222	
7			4.6	.061	1.227	
8			4.2	.029	1.214	
9			3.9	.010	1.232	14
10			4.2	.022	1.203	
11			3.9	.027	1.211	
12			4.0	.028	1.207	30
13			4.0	.028	1.210	
14			4.6	.024	1.212	
15			4.3	.024	1.240	14
16			4.0	.003	1.229	
17			4.0	.027	1.238	51
19			3.9	.025	1.239	
20			4.5	.058	1.238	
21			4.0	.038	1.240	
22			4.5	.027	1.245	33
23			4.0	.085	1.253	
24			4.2	.095	1.238	21
25			4.5	.044	1.253	
26			4.3	.086	1.257	
28			9.4	.031	1.249	
29			4.4	.030	1.248	29
30			4.4	.040	1.240	
31			4.4	.047	1.250	21
32			4.4	.047	1.260	
33			4.1	.026	1.248	
34			4.4	.046	1.243	
35			4.3	.055	1.252	
* - Following discharge						
N/A - not applicable						
□ - Only 2 cells in each group w/ gauges						

TABLE III
INTERNAL RESISTANCE AND SHORT TEST DATA

9ND-NADC (SP 11/73)

SERIAL NUMBER	INTERNAL RESISTANCE (MILLIOHMS)			INTERNAL SHORT TEST		
	END-OF-CHARGE	ONE HOUR AFTER START-OF-DISCHARGE	TWO HOURS AFTER START-OF-DISCHARGE *	AFTER 16 HR SHORT	AFTER 24 HOUR OCV STAND	
				CELL	CELL	PRESS <input type="checkbox"/>
36	N/A	N/A	4.3	.037	1.246	20
37			3.9	.018	1.246	
38			4.2	.050	1.256	17
39			4.2	.047	1.247	
40			4.4	.030	1.247	
41			4.7	.032	1.244	
42			4.7	.038	1.249	
44			4.7	.032	1.238	17
45			4.7	.037	1.237	
46			10.0 **	N/A	N/A	
47			4.6	.041	1.221	
49			4.8	.040	1.237	
50			3.5	.038	1.251	32
51			3.6	.029	1.250	
52			3.4	.033	1.248	21
53			3.5	.021	1.249	
54			3.6	.040	1.252	
55			3.6	.036	1.254	
56			3.7	.058	1.258	19
57			4.0	.049	1.254	
58			3.9	.051	1.255	17
59			3.9	.048	1.253	
60			3.9	.051	1.253	
61			4.1	.050	1.257	
62			4.2	.052	1.257	
63			4.0	.050	1.256	
64			3.6	.043	1.254	33
65			3.8	.045	1.261	
66			4.0	.039	1.251	26
67			3.9	.042	1.256	
68			4.0	.040	1.251	
69			3.9	.054	1.256	
70			4.0	.051	1.257	
* - Following discharge ** - Beginning of Test						
N/A - Not Applicable <input type="checkbox"/> - Only 2 cells in each group w/gauges						

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